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論文の内容の要約

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【論文の内容の要約】

Blueberry market demand has increased in Japan because blueberries are considered to be rich in phenolic compounds and high nutritional properties. However, the blueberry harvest season is very short in Japan and import is necessary during the offseason at a high price. Therefore, Japan needs to develop new cultivation methods for blueberry stable year-round production and the Tokyo University of Agriculture and Technology (TUAT) plant factory was established in 2011 to carry out researches for blueberry year-round production. Blueberry year-round production was succeeded in TUAT plant factory after 3 years but it was difficult to keep the continuous fruiting situation for the long term. Continuous fruit situation can be described as a good balance of fruits, flowers and new shoots in the plant. On the other hand, Light Emitting Diodes (LEDs) become popular to control plant morphology and flowering characteristics. However, there is no information about the influence of LEDs on blueberry flowering under a controlled environment. Therefore, this experiment was conducted to understand how light wavelengths influence on plant morphology, flowering characteristics for year-round production and fruit quality in ‘Misty’ and ‘Sharpblue’ blueberry. For lighting sources, 100% blue LED light, 100% red LED light, a mixture of red, blue and green LED lights (mixed LED) and fluorescent lamps were applied.

Firstly, the influence of different light quality on flowering characteristics, plant morphology, fruit quality and potential for year-round production in blueberry was studied (Chapter 2). The results showed that cumulative flower number was maximum

in ‘Misty’ under blue LED light and in ‘Sharpblue’ under mixed LED lights. In ‘Sharpblue’, red LED light encouraged vegetative growth, and plants under blue light were delayed in growth with the cessation of shoot elongation. However, a mixture of LED lights and fluorescent ones showed desirable vegetative growth and a high potential for continuous flowering.

As a next step, plant morphology, leaf characteristics, dry matter, and leaf photosynthetic activity in ‘Sharpblue’ were studied (Chapter 3). The results revealed plants irradiated with red LED light had the biggest leaf area but photosynthesis activity of the plants was in the third position. Red LED light encouraged vegetative growth ; leaf area, plant canopy, and the amount of dry matter weight were the second highest among treatments but very few fruits. On the other hand, the weakest plant vigor and the smallest leaf area, the poorest photosynthetic activity but many flowers were observed in plants under blue LED light. Under control and mixed LED lights, fruit yield, fruit quality, and plant morphological changes were in a positive trend, showing high potential for year-round fruit production in ‘Sharpblue’.

Finally, the influence of light qualities on fruit quality was studied in ‘Sharpblue’ (Chapter 4). Higher soluble solid content (SSC) and less titratable acidity (TA) were found in fruits under blue LED light and mixed LED lights. The red and mixed LED lights encouraged to accumulate total anthocyanin compared to that of fruits under blue light and control. However, the highest amount of total phenols and Oxygen Radical Absorbance Capacity (ORAC) value was observed in fruits under blue LED light.

In conclusion, it was observed that each ray of light had a specific influential effect on plant morphology, flowering characteristics and fruit quality in blueberry. To keep successful continuous fruiting situation for long term, this experiment introduced a new system for blueberry year-round production in a plant factory as follows:

Stage 1: Blue light alone can be used to induce flower when vegetative phase is active in plants;

Stage 2: when flowering starts, mixed LED lights can be used to induce continuous fruiting situation;

Stage 3: when plants become weak after some time, red light can be provided.

However, it is important to check plant vigor and morphology at every stage throughout the plant cultivation. A new method for a continuous fruiting system of blueberry using different LED light wavelengths in a plant factory was discussed in Chapter 5.